

CLAIMS

We claim:

1. A process for quenching a reactor effluent stream from an oxygenate to olefins reactor, the process comprising the steps of:
 - (a) quenching the reactor effluent stream in a first quench stage with a first quench medium comprising an aqueous solution to form a first liquid fraction and a first effluent stream;
 - (b) quenching the first effluent stream in a second quench stage with the first quench medium producing a second liquid fraction and a second effluent stream; and
 - (c) quenching the second effluent stream in a third quench stage with a second quench medium comprising a substantially oxygenate free quench medium.
2. The process of claim 1, wherein the reactor effluent stream comprises olefin product and water, the reactor effluent stream further being entrained with catalyst fines, wherein the first liquid fraction has no more than 20 wt.% water based upon the weight of water in the reactor effluent stream and a majority of catalyst fines based upon the amount of catalyst fines in the reactor effluent stream.
3. The process of claim 1, wherein the reactor effluent stream comprises olefin product and water, the reactor effluent stream further being entrained with catalyst fines, wherein the second quench stage removes a majority of water based upon the amount of water in the reactor effluent stream.
4. The process of claim 1, wherein the reactor effluent stream comprises olefin product and methanol, the reactor effluent stream further being entrained with catalyst fines, wherein the third quench stage removes a majority of methanol based upon the amount of water in the effluent stream.

5. The process of claim 1, wherein the reactor effluent stream comprises olefin product, methanol, and water, the reactor effluent stream further being entrained with catalyst fines, wherein:

the first liquid fraction has no more than 20 wt.% water based upon the weight of water in the reactor effluent stream and a majority of catalyst fines based upon the amount of catalyst fines in the reactor effluent stream;

the second quench stage removes a majority of water based upon the amount of water in the reactor effluent stream; and

the third quench stage removes a majority of methanol based upon the amount of methanol in the reactor effluent stream.

6. The process of claim 5, wherein the process further comprises the steps of:

(d) cooling the second liquid fraction to form the first quench medium.

7. The process of claim 6, wherein the first quench stage comprises a quench fitting and a first settling vessel, the first settling vessel having a top end, a bottom end, a first passage at the top end, a first outlet at the bottom end, and a second outlet between the top end and the bottom end, the process further comprises the steps of:

(e) withdrawing the first effluent stream through the first passage;

(f) separating, in the first settling vessel, a first portion of catalyst fines in the first liquid fraction from a partially clarified first liquid fraction, the partially clarified first liquid fraction comprising a second portion of the catalyst fines;

(g) withdrawing a first concentrated fines stream comprising the first portion of catalyst fines from the first outlet; and

(h) withdrawing the partially clarified first liquid fraction from the second outlet.

8. The process of claim 7, wherein the partially clarified liquid fraction is directed to a second settling vessel, the partially clarified liquid stream further comprises a hydrocarbon phase, and the process further comprises the steps of:

- (i) withdrawing a second concentrated fines stream from the second settling vessel, the second concentrated fines stream comprises substantially all of the second portion of catalyst fines from the second settling vessel;
- (j) combining the second concentrated fines stream with the first concentrated fines stream;
- (k) withdrawing a clarified aqueous stream; and
- (l) withdrawing a non-aqueous stream.

9. The process of claim 8, wherein the clarified aqueous stream comprises water and methanol, the process further comprising the steps of:

- (m) separating the clarified aqueous stream into a methanol fraction and a water fraction; and
- (n) feeding the methanol fraction into the oxygenate to olefin reactor.

10. The process of claim 7, wherein the quench fitting is a tubular member comprising a plurality of spray nozzles configured to spray the first quench medium into the reactor effluent stream.

11. The process of claim 5, wherein the second quench stage has a first quench inlet and a second quench inlet located above the first quench inlet, the process further comprising the step of:

- introducing the first quench medium into the first quench inlet at a first temperature and the second quench inlet at a second temperature that is at least about 2.7°C lower than the first temperature.

12. The process of claim 11, wherein the second temperature is at least 5.6°C lower than the first temperature.

13. The process of claim 11, wherein the second temperature is at least 11°C lower than the first temperature.
14. The process of claim 11, wherein the second quench stage further comprises a first condensate outlet, the process further comprising the steps of:
 - (i) withdrawing a portion of the second liquid fraction from the first condensate outlet; and
 - (ii) directing the portion of the second liquid fraction to the first quench inlet and the second quench inlet.
15. The process of claim 8, wherein the third quench stage comprises a second condensate outlet, the process further comprising the step of withdrawing the third liquid fraction from the second condensate outlet and combining it with the clarified aqueous stream.
16. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 75 wppm oxygenate hydrocarbons.
17. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 50 wppm oxygenate hydrocarbons.
18. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 10 wppm oxygenate hydrocarbons.
19. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 5 wppm oxygenate hydrocarbons.
20. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 1 wppm oxygenate hydrocarbons.

21. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 75 wppm methanol.

22. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 50 wppm methanol.

23. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 10 wppm methanol.

24. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 5 wppm methanol.

25. The process of claim 1, wherein the substantially oxygenate free quench medium has less than 1 wppm methanol.

26. A process for removing methanol from a reactor effluent stream withdrawn from an oxygenate to olefin reactor, the reactor effluent stream comprising methanol, olefin product and water, the process comprising the steps of:

- (a) quenching the reactor effluent stream with a first quench medium to remove at least 75 wt.% water based upon the total weight of water in the reactor effluent stream to produce a first effluent stream; and
- (b) quenching the first effluent stream with a second quench medium, wherein a majority of methanol in the second effluent stream is removed.

27. The process of claim 26, wherein the step of (a) quenching is done in two further steps, the further steps comprising:

- (a-i) cooling the reactor effluent stream forming a first liquid fraction having from about 3 wt.% to about 20 wt.% of the water based upon the total weight of water in the reactor effluent stream; and

(a-ii) quenching the reactor effluent stream after the step of (a-i) cooling to remove at least 75 wt.% water based upon the total weight of water in the reactor effluent stream.

28. The process of claim 27, wherein the step of (a-ii) quenching is done in two phases, a first phase and a second phase, wherein the temperature of the first quench medium entering the second phase is at least 2.8°C lower than the temperature of the first quench medium entering the first phase.

29. The process of claim 28, wherein the temperature of the first quench medium entering the second phase is at least 5.6°C lower than the temperature of the first quench medium entering the first phase.

30. The process of claim 28, wherein the temperature of the first quench medium entering the second phase is at least 11°C lower than the temperature of the first quench medium entering the first phase.

31. The process of claim 28, wherein the temperature of the first quench medium entering the second phase is at least 17°C lower than the temperature of the first quench medium entering the first phase.

32. The process of claim 27, wherein step (a-i) quenching produces a first liquid fraction comprising from about 3 wt.% to about 15 wt.% water based upon the total weight of water in the reactor effluent stream, and wherein the first liquid fraction further comprises substantially all of the catalyst fines that are entrained in the reactor effluent stream, the process further comprising the step of: separating water in the first liquid fraction from the catalyst fines in the first liquid fraction to produce a concentrated fines stream, the concentrated fines stream comprising catalyst fines from the first liquid fraction and a clarified liquid stream comprising water from the first liquid fraction.

33. The process of claim 32, wherein the clarified liquid stream further comprises methanol, the clarified liquid stream is further directed to a methanol fractionator to remove at least a majority of methanol that is present in the clarified liquid stream.

34. The process of claim 33, wherein the concentrated fines stream is concentrated to from about 3 wt.% to about 90 wt.% catalyst fines based upon the total weight of the concentrated fines stream.

35. The process of claim 26, wherein the steps of the process are done at a pressure of below 276 kPag.

36. The process of claim 26, wherein the steps of the process are done at a pressure of below 172 kPag.

37. The process of claim 26, wherein the steps of the process are done at a pressure of below 69 kPag.

38. A process for quenching an effluent stream comprising water, olefin product, and methanol, the effluent stream being entrained with catalyst fines, the process comprising the steps of:

- (a) removing at least 80 wt.% of the water based upon the total amount of the water in the effluent stream;
- (b) separating at least 95 wt.% of the catalyst fines based upon the total amount of the catalyst fines in the effluent stream; and
- (c) removing at least 97 wt.% of the methanol based upon the total amount of the methanol in the effluent stream, wherein steps (a), (b) and (c) are performed in a single quench tower apparatus.

39. The process of claim 38, wherein all of the steps of the process are done at a pressure of below 276 kPag.

40. The process of claim 38, wherein the steps of the process are done at a pressure of below 172 kPag.

41. The process of claim 38, wherein the steps of the process are done at a pressure of below 69 kPag.

42. The process of claim 38, wherein step (c) removing, removes at least 98 wt.% of the methanol based upon the total weight of the methanol in the effluent stream.

43. The process of claim 38, wherein step of (c) removing, removes at least 99 wt.% of the methanol based upon the total weight of the methanol in the effluent stream.

44. The process of claim 38, wherein step of (c) removing, removes at least 99.75 wt.% of the methanol based upon the total weight of the methanol in the effluent stream.

45. A process for quenching a reactor effluent stream comprising water, olefin product, and methanol, the reactor effluent stream being entrained with catalyst fines, the process comprising the steps of:

- (a) removing water from the reactor effluent stream;
- (b) separating catalyst fines from the reactor effluent stream; and
- (c) removing at least 97 wt.% of the methanol based upon the total weight of methanol in the reactor effluent stream, wherein the steps (a) (b) and (c) occur at a pressure less than 276 kPag.

46. The process of claim 45, wherein the steps of the process are done at a pressure of below 172 kPag.

47. The process of claim 31, wherein the steps of the process are done at a pressure of below 69 kPag.

48. The process of claim 45, wherein the step (c) of removing, removes at least 98 wt.% of the methanol based upon the total weight of the methanol in the reactor effluent stream.

49. The process of claim 45, wherein the step (c) of removing, removes at least 99 wt.% of the methanol based upon the total weight of the methanol in the reactor effluent stream.

50. The process of claim 45, wherein the step (c) of removing, removes at least 99.75 wt.% of the methanol based upon the total weight of the methanol in the reactor effluent stream based upon the total weight of the methanol in the reactor effluent stream.

51. A quench process of a reactor effluent stream withdrawn from a reactor in a process for converting methanol into olefin product, the reactor effluent stream comprising olefin product, water, and methanol, the reactor effluent stream being entrained with catalyst fines, the process comprising the steps of:

- (a) contacting the reactor effluent stream with a first quench medium in a first quench stage to form a first effluent stream within a first quench tower;
- (b) withdrawing a first liquid stream from the reactor effluent stream to form a first effluent stream, the first liquid stream comprising catalyst fines and water;
- (c) contacting the first effluent stream with the first quench medium in a second quench stage;
- (d) cooling a portion of the first quench medium to form a cooled first quench medium, and contacting the first effluent stream with the first cooled quench medium in the second quench stage;

- (e) withdrawing a second liquid stream in the second quench stage to form a second effluent stream;
- (f) contacting, in a third quench stage, the second effluent stream with a second quench medium comprising substantially oxygenate free quench medium; and
- (g) withdrawing a third liquid stream in the third quench stage to form a third effluent stream, the third liquid stream comprising water and methanol.

52. The process of claim 51, wherein the step (a) of contacting is done in a quench fitting.

53. The process of claim 51, further comprising the step of cooling a portion of the second liquid stream to form the first quench medium.

54. The process of claim 51, further comprising separating catalyst fines from the first liquid stream.

55. The process of claim 51, wherein the first liquid stream further comprises methanol, the process further comprising the step of separating methanol in the third liquid stream from a portion of the first liquid stream to form the third quench medium.

56. The process of claim 51, wherein the second liquid stream further comprises methanol, the process further comprising the step of separating methanol in the third liquid stream from a portion of the second liquid stream to form the third quench medium.

57. The process of claim 51, further comprising the step of separating methanol from a portion of the first liquid stream to form the third liquid stream.

58. The process of claim 51, wherein the steps (b) through (g) are done in a single multi-staged quench tower.

59. The process of claim 51, wherein the first quench medium is at least 2.7°C lower than the second quench medium.

60. The process of claim 51, wherein the steps (a) through (g) are done at a pressure of no greater than 276 kPag.

61. The process of claim 51, wherein the first liquid stream comprises no less than 50 wt.% catalyst fines based upon the total weight of catalyst fines in the reactor effluent stream.

62. The process of claim 51, wherein the first liquid stream comprises no less than 90 wt.% catalyst fines based upon the total weight of catalyst fines in the reactor effluent stream.

63. The process of claim 51, wherein the first liquid fraction comprises no greater than about 20 wt.% water based upon the total weight of water in the reactor effluent stream.

64. The process of claim 51, wherein the second effluent stream comprises no more than 15 wt.% water based upon the total weight of water in the reactor effluent stream.

65. The process of claim 51, wherein the second effluent stream comprises no more than 10 wt.% water based upon the total weight of water in the reactor effluent stream.

66. The process of claim 51, wherein the third effluent stream comprises no more than 3 wt.% methanol based upon the total weight of methanol in the reactor effluent stream.

67. The process of claim 51, wherein the temperature of the reactor effluent stream is from about 250°C to about 800°C at the time the reactor effluent leaves the reactor.

68. The process of claim 51, wherein the temperature of the reactor effluent stream is from about 93°C to about 204°C just prior to the step (a) of contacting.

69. The process of claim 51, wherein the temperature of the first effluent stream is from about 71°C to about 133°C after the step (b) of withdrawing.

70. The process of claim 51, wherein the temperature of the first effluent stream is from about 99°C to about 110°C after the step (b) of withdrawing.

71. The process of claim 51, wherein the temperature of the second effluent stream is from about 27°C to about 54°C after the step (e) of withdrawing.

72. The process of claim 51, wherein the temperature of the second effluent stream is from about 32°C to about 49°C after the step (e) of withdrawing.

73. The process of claim 51, wherein the temperature of the third effluent stream is from about 10°C to about 49°C after the step (g) of withdrawing.

74. The process of claim 51, wherein the temperature of the third effluent stream is from about 16°C to about 43°C after the step (g) of withdrawing.

75. A process for removing methanol from a reactor effluent stream using a quench device, the process comprising the steps of:

- (a) passing a reactor effluent stream through two quench stages using the same quench medium to form a second effluent stream; and
- (b) introducing the second effluent stream to at least one or more quench stages to produce a third effluent stream that has no more than 95 wt.% water based upon the weight of the third effluent stream.